criteria are met:

- Safety problems exist and the roadway cannot be improved with bicycle lanes
- Bicycling volumes are high
- A conflict or obvious courtesy problem exists between motor vehicle and bicycle traffic sharing the road

Other Bicycle Facilities and Amenities

The *North Carolina Bicycle Facility Planning and Design Guidelines* also provide design considerations and recommendations for other types of ancillary bicycle facilities and amenities. These items, such as bike racks, bikes on buses, and bike-friendly drainage grates and railroad crossings help to complete the bicycle system by eliminating barriers and providing security. In addition, the guidelines also discuss the maintenance of bicycle facilities, which is essential for the continued safe travel of bicyclists. Ancillary bicycle facilities and amenities are discussed in a subsequent section.

Recommendations for Incorporating Bicycle Facilities

When feasible, all new collector and arterial roadways in New Bern should include bicycle lanes when they are constructed. New construction is the easiest and most cost-effective opportunity to include bicycle facilities because they can be integrated as a part of a larger roadway project.

When collector and arterial roadways are resurfaced or reconstructed, the City of New Bern should evaluate the roadway cross-section to identify opportunities for bicycle facilities. This evaluation should consider how much motor vehicle travel lane width can be re-allocated and used for bike lane or shoulder space, given the lane configuration, traffic volumes, and traffic composition of the roadway. Two types of modifications should be considered to provide additional pavement width for bicycling: striping narrower lanes and/or removing travel lanes on roads with excess capacity. Reconfiguring a roadway during a reconstruction project is also more cost-effective than adding shoulders or restriping lanes as an independent retrofit project.

Neighborhood streets and rural roadways with low traffic volumes may be suitable for bicycling as shared roadways (e.g., special bicycle facilities are not needed).

Recommended Changes to New Bern Street and Sidewalk Standards

Land development and redevelopment projects are excellent opportunities to improve conditions for bicycling in New Bern. The City can ensure that bicycle facilities are provided as a part of development projects by updating its municipal code. For example, the current code states that shoulders (minimum 6-foot width) must be provided on all arterial and collector roadways constructed without curb and gutter.

This plan recommends several revisions to the New Bern municipal code.

Article XIV: Streets and Sidewalks

- Require bicycle lanes to be provided on all roadways classified as arterials
- Require bicycle lanes to be provided on all roadways classified as collectors
- Remove the statement that encourages cul-de-sacs (this development pattern increases the total distance that people need to bicycle, walk, and drive to reach destinations)

Article XVIII: Parking

- Add minimum bicycle parking space requirements for different types of land uses

Sample Cross-Sections

A set of sample cross-sections has been developed to reflect road treatments for specific bicycle recommendations. These cross-sections can be adapted to correspond to different road conditions and attributes as necessary. **Figure 3.5** corresponds to a cross-section with striped bike lanes. **Figure 3.6** corresponds to a cross-section with striped bike lanes and parking. **Figure 3.7** denotes a cross-section that has used differential striping to obtain wide outside lanes. **Figure 3.8** shows a cross-section containing a multi-use path on one side of the road.

Roadway Intersections

Intersections should be designed with a balanced level of accommodation for all modes, including pedestrians, bicyclists, motor vehicle traffic, and public transit. Narrow intersections decrease crossing distances for all users, including bicyclists. Narrower intersections can have a shorter traffic signal cycle length than wide intersections (when the intersection is signalized) and are safer for pedestrians and bicyclists, in general.

Special care must be given to bike lane design at intersections. Since intersections represent significant conflict points for bicyclists, appropriate striping, marking, and signing is critical to help ensure the proper behavior of cyclists and motorists.

When designing bike lanes at intersections, the City of New Bern should follow examples in the Pedestrian and Bicycle Information Center's *Bike Lane Design Guide*, which can be downloaded at www.bicyclinginfo.org/de/bikelaneguide.htm.

This document is a summary of the *Chicago Bike Lane Design Manual*. Four example intersection striping treatments are provided at the end of this section.

Signal Loops. Bicyclists frequently have trouble being detected at traffic signals. They often believe the signals are non-responsive and consequently run red lights. However, most traffic signal loops designed for motorists can detect bicyclists if the cyclists know where to place their bicycle. One effective way to address this problem is to mark the location on the pavement where a cyclist would have to stop the bike to be detected by a traffic signal. The sign pictured here and the symbol it shows have been tested for cyclist understanding and are being considered for future updates to *MUTCD*. To implement them before they are included in the *MUTCD* on federal or state-maintained roads would require a request to experiment be filed with FHWA. Another alternative would be to implement these loops as demonstration projects on municipal streets

Specific signal loops for bike lanes (or multi-use paths) can also serve to improve cycling conditions. A typical treatment is a quadrapole loop with overall dimensions of 2 feet by 20 feet.

Figure 3.5 Striped Bike Lanes Cross-Section

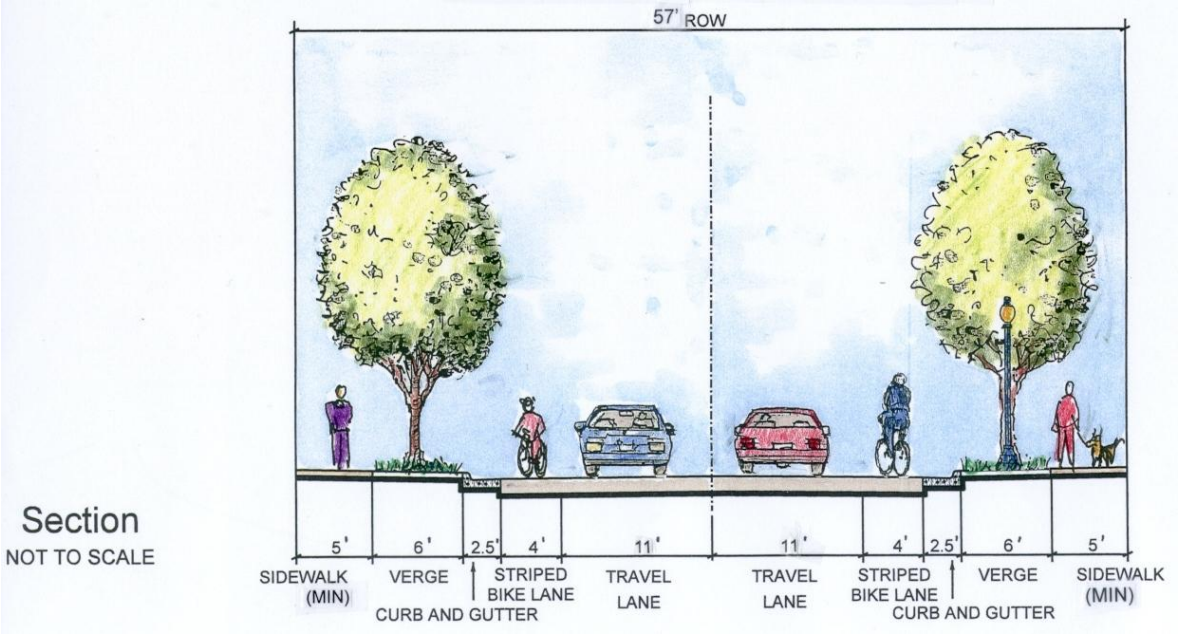


Figure 3.6 Striped Bike Lanes and Parking Cross-Section

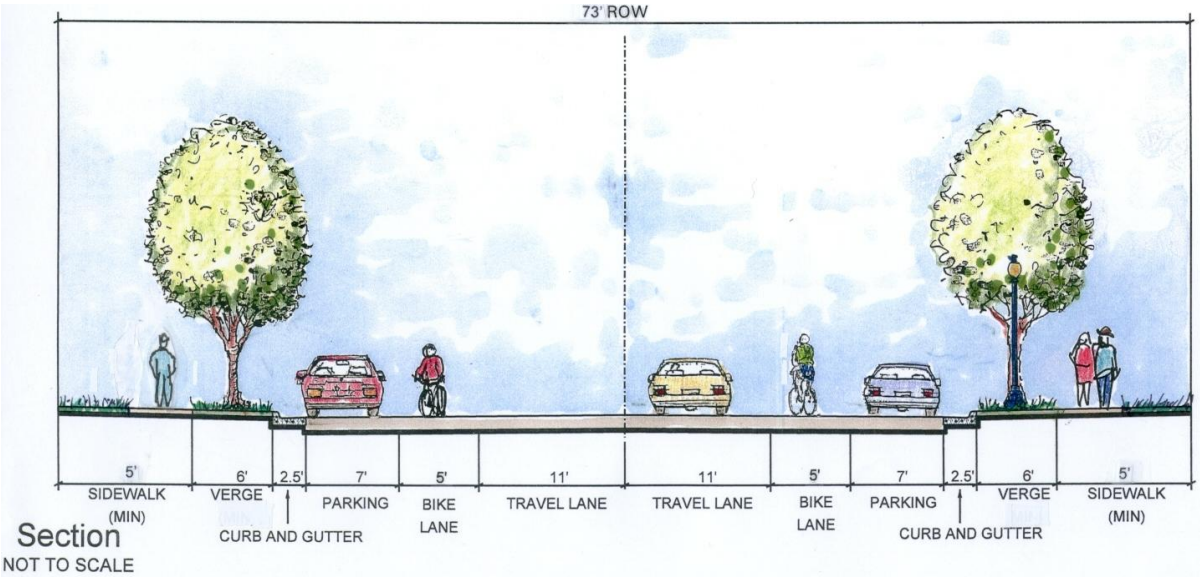


Figure 3.7 Wide Outside Lanes Cross-Section

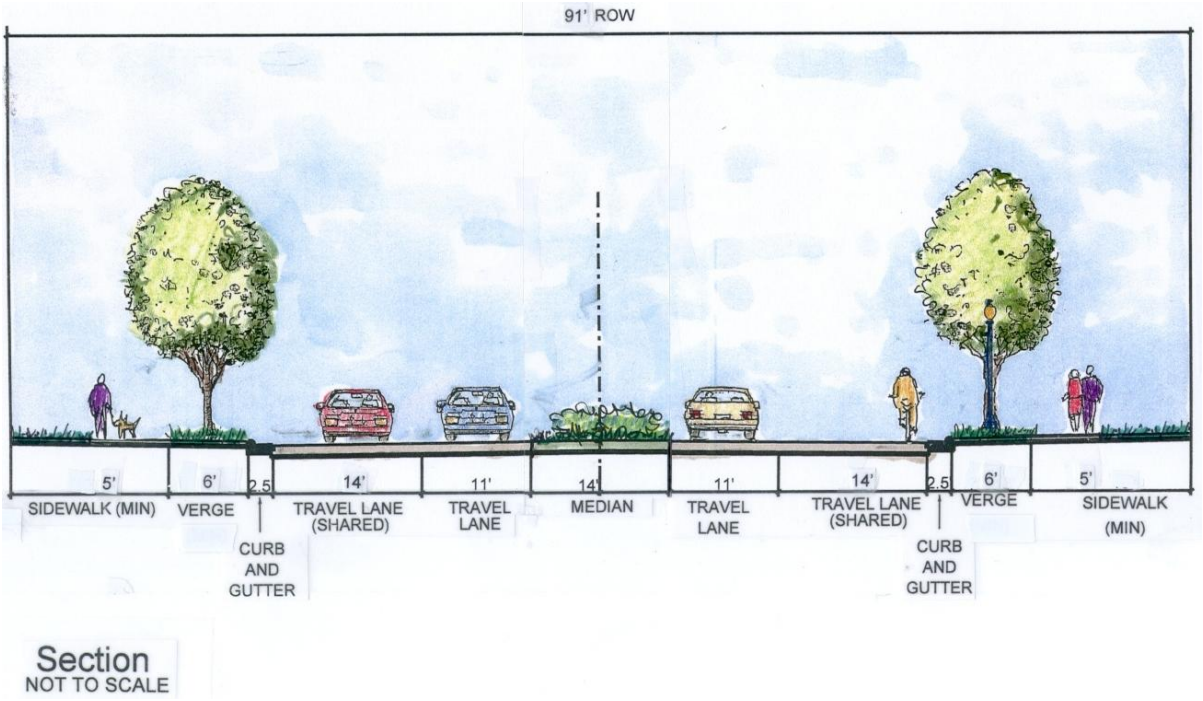
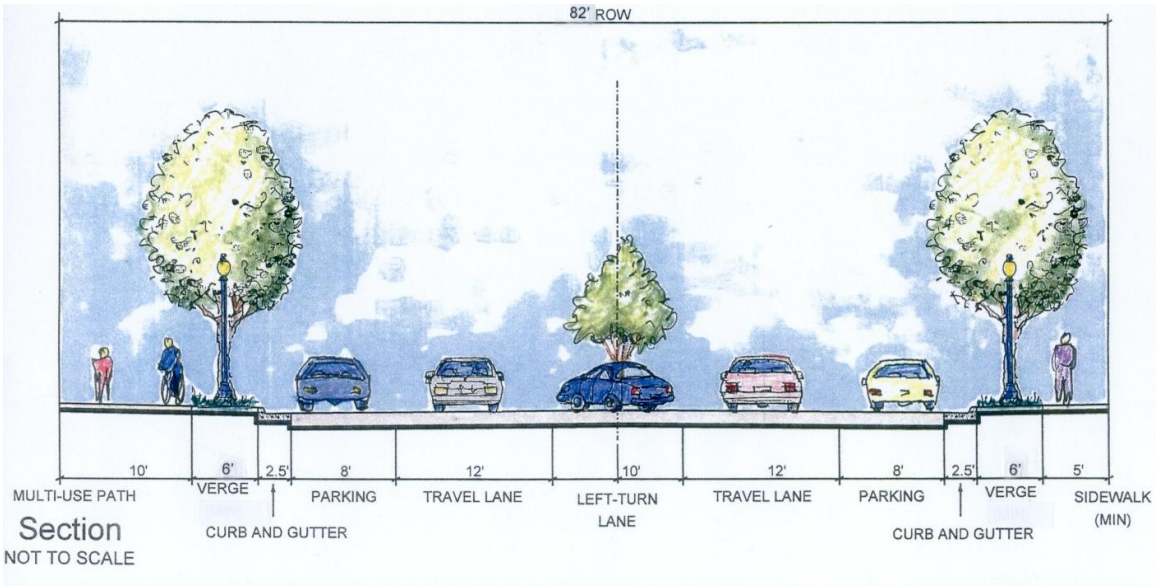
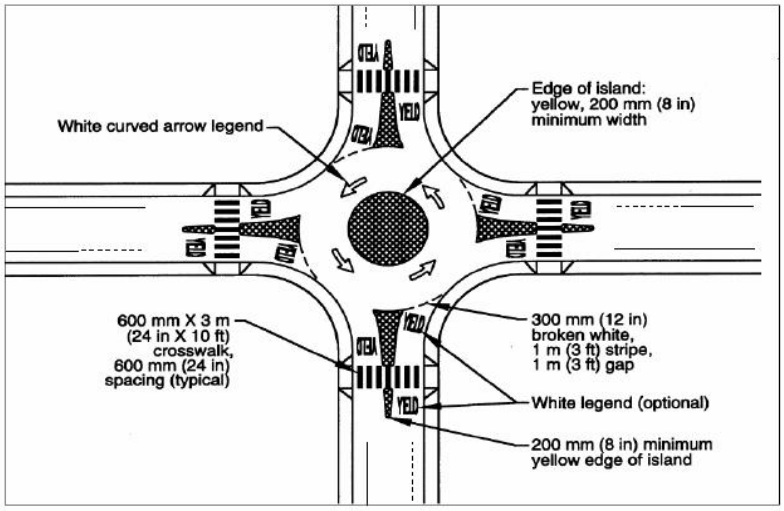


Figure 3.8 Sidepath Cross-Section



Roundabouts. Bicycles fare well at urban compact roundabouts. With low design speeds, minimized conflict areas, and yield upon entry traffic control, well-designed urban compact roundabouts are convenient and safe for bicyclists. The approaches to roundabouts should be treated just as any other unsignalized intersection: the bike lanes should be terminated prior to the roundabout, and cyclists should be allowed to claim the lane in the circulating roadway. An example drawing of this treatment, from the FHWA design guide[19] (with a modification to show approach bike lanes) is shown in **Figures 3.9** and **3.10**.

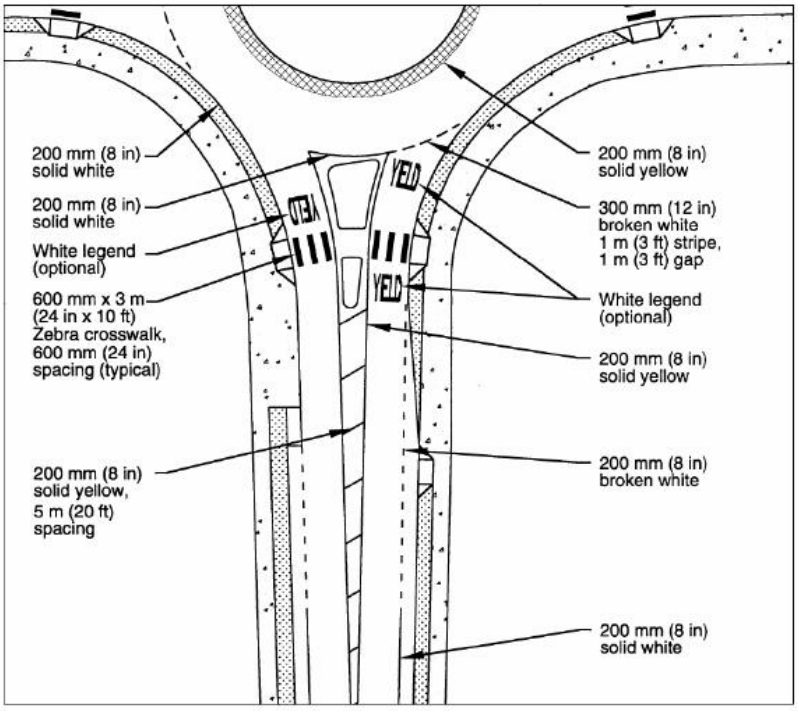
Figure 3.9 Roundabout with Bicycle Accommodations



Roundabouts: An Informational Guide FHWA-RD-00-67, June 2000 (modified)

It should be noted that the MUTCD states, "Bicycle lanes shall not be provided on the circular roadway of a roundabout intersection." This statement is made as a STANDARD and is thus not to be violated. At roundabouts, such as the examples shown in **Figures 3.9** and **3.10**, bicyclists should be given a choice to either claim the lane and ride through the circulating roadway, or to move to a widened sidewalk and traverse the roundabout as pedestrians.

Figure 3.10 Roundabout Detail with Bicycle Accommodations

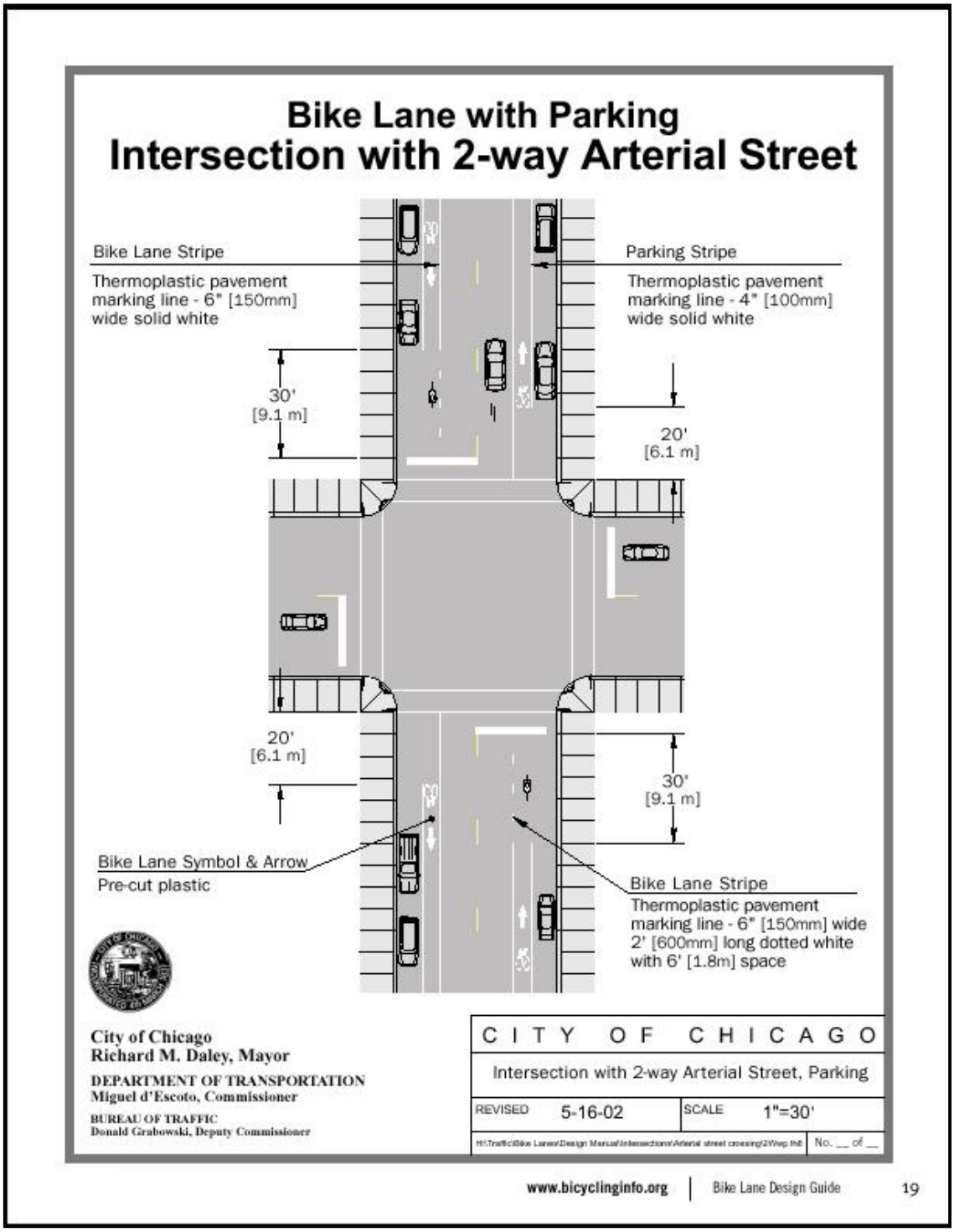


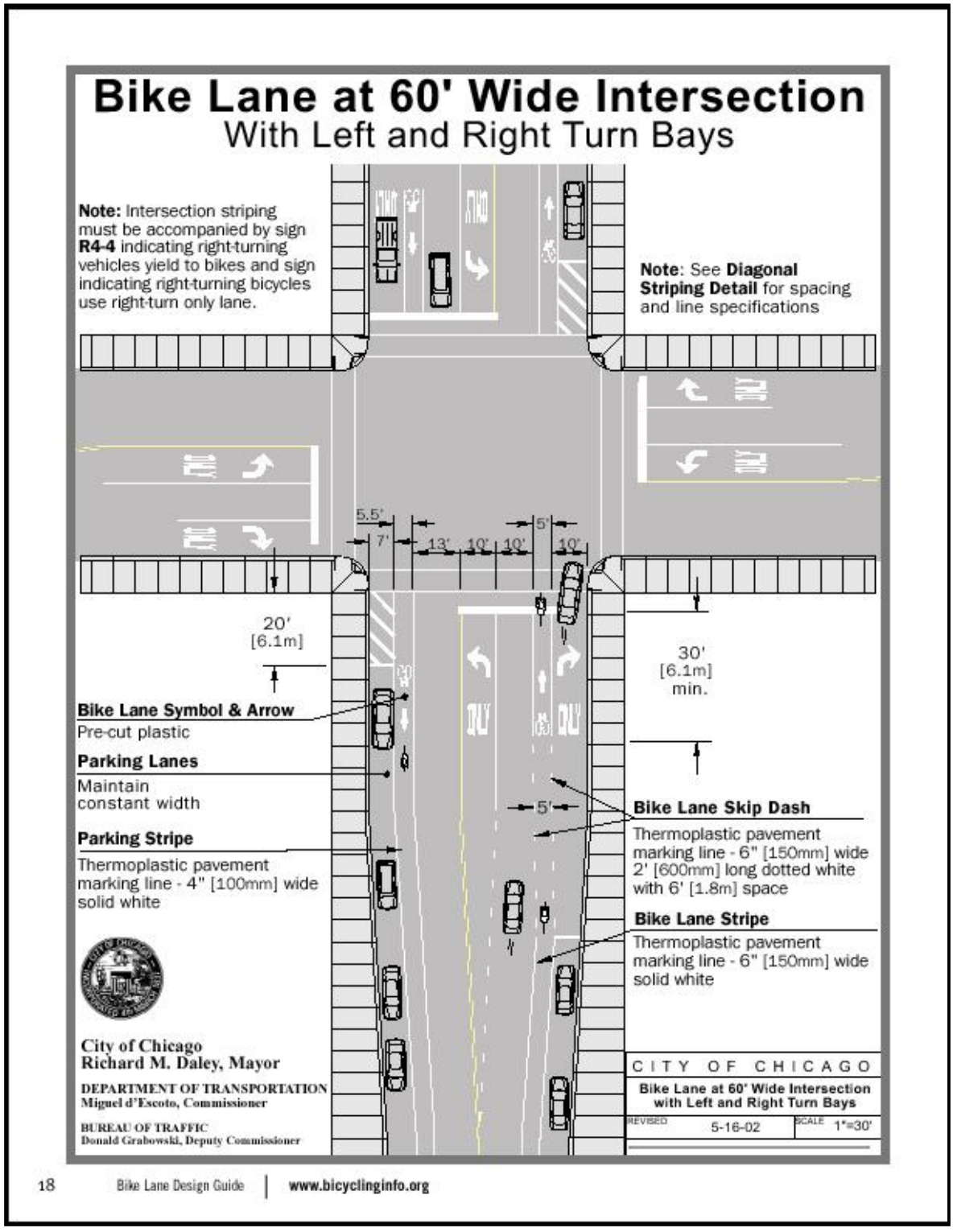
Roundabouts: An Informational Guide FHWA-RD-00-67, June 2000

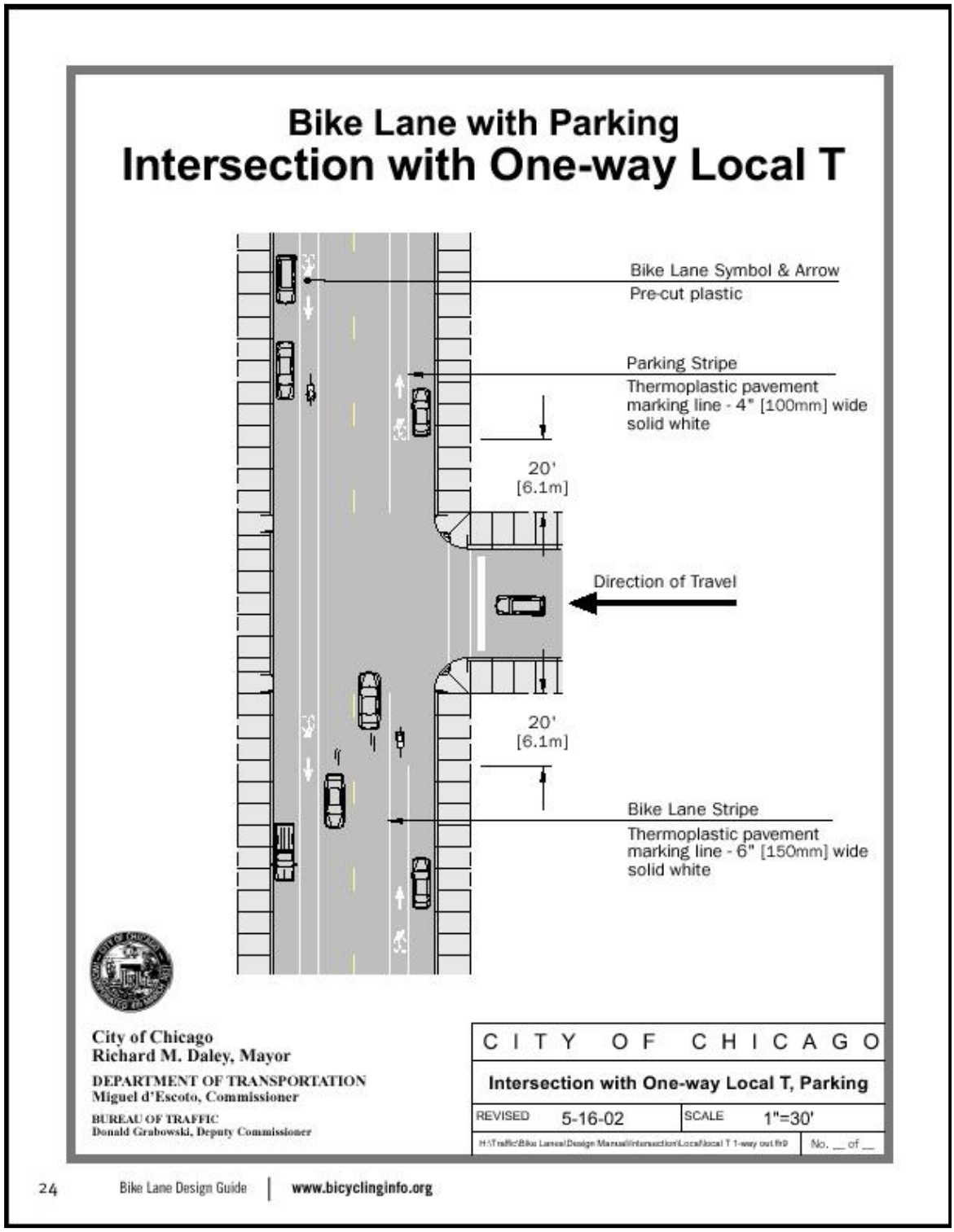
[19] FHWA, Roundabouts: An Informational Guide, FHWA-RD-00-67, McLean, VA, June 2000.

Example Intersection Striping Treatments

Figure 3.11 Example Intersection Striping Treatments




Bike Lane at 60' Wide Intersection
With Left and Right Turn Bays
Note: Intersection striping must be accompanied by sign R4-4 indicating right-turning vehicles yield to bikes and sign indicating right-turning bicycles use right-turn only lane.
Note: See Diagonal Striping Detail for spacing and line specifications
5.5'
7'
13'
10'
10'
5'
10'
20'
[6.1m]
30'
[6.1m]
min.
Bike Lane Symbol & Arrow
Pre-cut plastic
Parking Lanes
Maintain constant width
Parking Stripe
Thermoplastic pavement marking line - 4" [100mm] wide solid white
5'
Bike Lane Skip Dash
Thermoplastic pavement marking line - 6" [150mm] wide 2' [600mm] long dotted white with 6' [1.8m] space
Bike Lane Stripe
Thermoplastic pavement marking line - 6" [150mm] wide solid white
City of Chicago
Richard M. Daley, Mayor
DEPARTMENT OF TRANSPORTATION
Miguel d'Escoto, Commissioner
BUREAU OF TRAFFIC
Donald Grabowski, Deputy Commissioner
CITY OF CHICAGO
Bike Lane at 60' Wide Intersection with Left and Right Turn Bays
REVISED 5-16-02
SCALE 1"=30'
18 Bike Lane Design Guide | www.bicyclinginfo.org


Bike Lane with Parking
Intersection with One-way Local T
Bike Lane Symbol & Arrow
Pre-cut plastic
Parking Stripe
Thermoplastic pavement marking line - 4" [100mm] wide solid white
20'
[6.1m]
Direction of Travel
20'
[6.1m]
Bike Lane Stripe
Thermoplastic pavement marking line - 6" [150mm] wide solid white
City of Chicago
Richard M. Daley, Mayor
DEPARTMENT OF TRANSPORTATION
Miguel d'Escoto, Commissioner
BUREAU OF TRAFFIC
Donald Grabowski, Deputy Commissioner
CITY OF CHICAGO
Intersection with One-way Local T, Parking
REVISED 5-16-02
SCALE 1"=30'
No. __ of __
24
Bike Lane Design Guide
www.bicyclinginfo.org

Sample Cost Estimates

To accommodate the bicycle facilities being considered, a set of sample construction cost estimates were developed. These cost estimates were derived based on unit costs for similar facilities in other areas as well as by referencing the NCDOT cost estimation spreadsheet. Each unit cost is included below, along with a description of how it was obtained. The construction costs do not include right-of-way acquisition or mitigation. Relocation of utility poles is not considered due to the large variability associated with a specific scenario. Potential replacement of drainage grates is estimated between $150 to $500 depending on the necessity of replacing the frame. Railroad flangeway fillers are estimated at a cost of $500 per site, excluding additional crossing mitigation such as concrete pads and other surface treatments. All estimates are provided in 2006 dollars.

Multi-Use Path:
$300,000 to $500,000 per mile

This estimate assumes a 10 foot wide asphalt surface and does not include other potential mitigation such as building a structure over a wetland area.

Wide Paved Shoulder:
$300,000 to $400,000 per mile

This figure assumes a 4 foot wide paved shoulder on both sides of the road being built where there is currently a grass shoulder. Other factors such as extensive ditch work are not considered.

Signed Route:
$250 per sign or $1000 per mile

This estimate for bicycle route signage accounts for four signs to be placed in a mile section, with two signs in each direction. Many bicycle routes in urban and suburban areas require more than four signs per mile.

Striped Bike Lanes:
$15,000 per mile

The estimate for striped bike lanes accounts for striping lanes (thermoplastic) in each direction and signing the route. Also, painting the bike lane on municipal roads with a more visible color may be desired at a cost of $25,000 per mile. This will help to calm traffic by creating a sense of enclosure. These lanes are often created in conjunction with resurfacing projects; however, the cost of resurfacing is not included here.

Wide Outside Lanes:
$15,000 per mile

Wide outside lanes are used here when differential striping can be applied to a roadway. As a result, no additional widening is necessary. The estimate accounts for the cost of restriping and signing the route.

Signed Route with Striped Parking:
$15,000 per mile

These routes are again the result of working within the existing cross-section to create a new facility type. This estimate accounts for striping and signing costs.

Neighborhood Connector:
$50,000 to $85,000 for a prefabricated or removeable bridge.

This estimate assumes that the neighborhood connector would consist of a prefabricated bridge run for a short section over a stream or other barrier.

Ancillary Facilities and Programs

Mapping and Signing Projects

Comprehensive Route Systems

The recommendations shown in **Chapter 4** have been set forth in order to create a comprehensive route system for the City of New Bern linking commercial, recreational, and residential areas. Over the next twenty years, the implementation of these routes will ultimately result in an interconnected set of facilities. To accommodate these facilities, the proposed area-wide Bike Route System should be mapped and signed with bicycle route signs. Potential improvements are identified in this chapter. These recommendations encompass issues from maintenance to design and include but are not limited to:

- Provision of bike lanes on local streets where space is available and on-street parking is not an issue
- Exploration of the use of the shared lane symbol under restricted conditions
- Marking and signing traffic signal loops (and possibly recalibrating them) for bicyclists
- Replacing unsafe utility covers and catch basins within the bicyclists' line of travel
- Marking railroad crossings to improve safety
- Route signage

While the first five items listed above are important for the bicyclist who has decided to use a specific route, the last — route signage — is critical to helping cyclists determine which route to use. Route signage should provide useful information to the bicyclists. When creating a route system signing plan, the destinations being served and the best roadways (or facilities) to access those destinations must be considered. Signing should include information on the direction and distance to destination points, as well as intermittent confirmation that the bicyclist is still on the correct route.

Facilities that can be used to create a comprehensive route system include multi-use paths, bike lanes, shoulders, and wide outside curb lanes.

State/Regional Routes

Any route system implemented by New Bern should consider the existing state routes that run through the area. This plan incorporates the North Carolina Cross-State Bicycling Highways 3 and 7 into its facility recommendations. These routes should also be incorporated into the local comprehensive route system. State and regional routes benefit the local community with support from other jurisdictions, organized promotion, and occasional funding.

Share the Road Signing Initiative

North Carolina has been installing "Share the Road" signage since 1987. Although it was not part of the *Manual on Uniform Traffic Control Devices* (MUTCD) at that time, the sign has since been standardized and included in that manual. The sign, shown here, serves to make motorists more aware of the possibility of bicyclists on high-use roads with potentially hazardous conditions. When this sign is placed along a bicycle route, it

typically denotes a major roadway connecting with less frequently traveled roads. These signs serve as important and cost-effective safety and education tools. In fact, the visibility and impact of these signs has recently been acknowledged by the state by the issuing of a "Share the Road" license plate. The additional funds received through the sale of this license plate will be used to promote bicycle education and safety initiatives statewide.

Suitability Rating System

The bicycle level of service (LOS) methodology allows planners and designers to select a level of accommodation rather than a required specific design treatment to provide for bicyclists along a bike route. What the bicycle LOS methodology does not do is dictate what level of service is appropriate for a given community or user. This means that a community can decide that for one type of bike route system, such as a neighborhood route system, an LOS A or B may be required. Conversely, LOS C may be acceptable for the routes serving cross-town commuter cyclists. In addition to being widely accepted by state DOTs and local jurisdictions, the bicycle LOS method is also being considered as the basis for a national LOS model to be included in the Highway Capacity Manual.

A bicycle level of service analysis was not conducted as a part of this study. However, it is recommended that the city works with neighboring municipalities and Craven County to perform a level of service analysis with a corresponding map component. Ultimately this exercise also could serve as a benchmark for the road system in New Bern during future re-evaluations of the system.

Spot Improvement/Maintenance Programs

General Considerations

All non-Interstate roadways should be maintained so they are safe for bicyclists to use. The surface should be free of debris. Longitudinal cracks should be patched and drainage grates with longitudinal slots should be replaced. Utility covers should be flush with the roadway surface. Paved shoulders should be installed where rutting is occurring on the side of non-curb and gutter roadways. Potholes should be filled and maintained regularly. These items should be addressed through the normal roadway maintenance and Powell Bill program.

The alignment of drainage grates and gutter pans with existing pavement is also an area of concern in New Bern. Over repeated repavings, the pavement level on streets with curb and gutter can become significantly higher than the gutter pan. This poses a safety hazard for bicyclists and cars by creating a dangerous edge of pavement. This situation can be avoided by milling down the pavement so that a repaving will be flush with the

gutter pan or by raising the drainage grates and paving all the way to the curb.

Bicycle facilities, including trails, require an additional level of effort to provide acceptable maintenance. Maintenance issues occur most frequently on the right side of the pavement, where the cyclist is likely to be riding. Consequently, a more frequent maintenance cycle to address these defects should be provided for bicycle routes. Areas such as bridges where excessive debris tends to build up and bicyclists have limited refuge options should be maintained even more frequently. Examples of this include the US 17-Neuse River Bridge and the Trent River Bridge.

Signal Clearance

Traffic signal timing and loops along bicycle facilities require extra attention. According to the *MUTCD*[20],

> "At installations where visibility-limited signal faces are used, signal faces shall be adjusted so bicyclists for whom the indications are intended can see the signal indications. If the visibility-limited signal faces cannot be aimed to serve the bicyclist, then separate signal faces shall be provided for the bicyclist.
>
> On bikeways, signal timing and actuation shall be reviewed and adjusted to consider the needs of bicyclists."

While the former can be easily evaluated, the latter concern (that of signal timing) is a little harder to address. The *AASHTO Guide for the Development of Bicycle Facilities* [21] provides information of clearance intervals and minimum green times for bicyclists. At wide intersections, the clearance interval equation can result in some excessively long yellow-plus-all red periods for signals. If the facility consists of a multi-use path or a bike lane, a signal loop can be placed in the bike lane or on the path in advance of the intersection. When a cyclist passes over the loop, the signal will extend the green time for the intersection approach to accommodate the crossing cyclists. This treatment is in common use for motorists and has been applied in various locations for bikes. The design of the loop is critical; an oversized loop in a bike lane will detect cars in the adjacent lane. An effective loop design for detecting bikes in bike lanes is a quadrapole 2 feet wide and 20 feet long (approximately half the size of a normal 40 foot roadway loop). Such a loop readily detects cyclists, but will not detect a car six inches to the side.

Roadway Symbol Buildup

Thermoplastic buildup is another concern of bicyclists. Bike lane symbols, lane use (directional) symbols, even crosswalks can all build up with repeated application and cause handling problems for bicyclists. More than two layers of thermoplastic (one marking) should not be allowed on bicycle facilities.

The slipperiness of thermoplastic and paints is another concern of bicyclists. One way to mitigate this concern is to add sharp silica sand to the glass spheres that make up the wet thermoplastic or paint. This increases the roughness of the markings' surface, reducing the potential for bicyclists to slip on the thermoplastic.

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[20] FHWA, *Manual on Uniform Traffic Control Devices*, pg. 9D-1, Washington, DC, 2003.

[21] *AASHTO Guide for the Development of Bicycle Facilities*, pg. 65, American Association of State Highway and Transportation Officials, Washington, DC, 1999.